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DIAGNOSIS AND TREATMENT OF POISONING BY PESTICIDES

Environmental Protection Agency
Washington, D. C.

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NTIS

Diagnosis & Treatment of Poisoning by Pesticides

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Pesticide Programs
Washington, D.C. 20460

Diagnosis and Treatment of Pesticide Poisoning

Pesticide chemicals can be safe and effective when used as recommended. They may be dangerous if directions are not followed.

With the DDT ban, effective January 1, 1973, the use of a variety of other chemicals must be increased to substitute for DDT in the control of insects.

Replacement chemicals will probably include among others:

Organophosphates: Azodrin®, Bidrin®, demeton (Systox®), dimethoate (Cygon®), disulfoton (DiSyston®), Meta-Systox-R®, phorate (Thimet®), mevinphos (Phosdrin®), parathion and methyl parathion, TEPP, azinphosmethyl (Guthion®).

Carbamates: aldicarb (Temik®), arprocarb/propoxur (Baygon®), carbofuran (Furadan®), methomyl (Lannate®), aminocarb (Matacil®), Zectran®, carbaryl (Sevin®).

Chlorinated hydrocarbons: BHC, lindane, methoxychlor, chlordane, aldrin, dieldrin, heptachlor, endrin.

Botanicals: pyrethrins.

Chemicals replacing DDT will be less persistent in the environment than DDT. Some of them will already be known to the user; others will be new and strange to him. Some replacement chemicals will be more acutely toxic to man and, therefore, will present greater potential hazards; others will be less acutely toxic but may still be hazardous to man under some conditions. Many of the chemicals that will probably be used as replacements are readily absorbed through the skin and by ingestion.

An intensive short-term educational program, **Project Safeguard,** is underway to train the farmer in the safe use of these replacement chemicals, and this program should minimize the hazards from improper use. The potential still exists, however, for an increased incidence of toxic exposure and resulting clinical illness, in which accurate diagnosis and prompt treatment could mean the difference between life and death.

Essential to the correct diagnosis of pesticide poisoning are:

1. **A high index of suspicion.**
2. **A history of opportunity for adequate exposure, compatible with time-dose relationships.**
3. **Consistent clinical manifestations.**
4. **Laboratory confirmation**

The toxic dose and clinical picture of poisoning vary with compound and formulation and possibly with individual.

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ORGANOPHOSPHATES

Organophosphates are permanent inhibitors of acetylcholinesterase. They are rapidly absorbed into the body by ingestion, through intact skin including the eye (even more efficiently through cuts, abrasions, areas of dermatitis, etc.), and by inhalation. Organophosphates may be direct or delayed enzyme inhibitors depending on whether the compound itself is active or whether it must be metabolized to another compound to become active.

This is one factor which mediates the rapidity of onset of illness. Symptoms may begin almost immediately after exposure to a direct inhibitor, such as mevinphos, or TEPP, while symptoms may be delayed several hours after an equal exposure to a delayed inhibitor, such as parathion, Guthion, or phorate. Dose and dose-interval also affect the speed with which manifestations occur. Onset of symptoms more than 12 hours after the termination of exposure excludes the diagnosis of organophosphate poisoning. Clinical manifestations result from the presence of excess acetylcholine and are varied; those most commonly present include headache, visual disturbances, pupillary abnormalities, and greatly increased secretions – sweating, respiratory secretions, tearing. More severe poisoning may be evidenced by nausea and vomiting, pulmonary edema, changes in heart rate, muscle weakness, respiratory paralysis, confusion, convulsions or coma, and death. Signs

Signs and Symptoms in Patients with Parathion Poisoning

Manifestation	Total Number Patients with manifestation	Serum Cholinesterase Activity in Symptomatic Patients*		
		0-10% of normal	11-20% of normal	21-50% of normal
		number of patients		
Weakness	47	14	11	22
Headache	46	14	11	21
Sweating	44	14	10	20
Nausea and vomiting	42	14	11	17
Salivation	31	13	8	10
Miosis	25	14	6	5
Dyspnea	23	14	6	3
Difficulty in walking	22	14	8	0
Diarrhea	21	9	4	8
Muscular fasciculation	20	14	6	0
Disturbance in speech	20	14	6	0
Disturbance in consciousness	19	14	5	0
Abdominal pain	15	5	4	6
Fever	15	9	6	0
Bronchopharyngeal secretion	14	10	4	0
Increased blood pressure	12	10	2	0
Loss of pupillary reflex	10	10	0	0
Cramp	9	9	0	0
Cyanosis	8	8	0	0

*Compared with normal value of each patient after recovery from poisoning.

Modified from Nambe, T., C. T. Nolte, J. Jackrel, and D. Grob. 1971. Poisoning due to organophosphate insecticides: acute and chronic manifestations. Am. J. Med. 50:475-492. Reprinted with permission from author and publisher.

and symptoms which occur, as well as the rate and extent of their progression, are dose-dependent.

Diagnosis of organophosphate poisoning may also be confirmed by a therapeutic trial with atropine, which is specific and effective. Individuals poisoned by cholinesterase-inhibiting compounds respond favorably to it and have a tolerance for relatively large doses given repeatedly. Similarly, marked improvement after a single dose of pralidoxime chloride (2-PAM chloride) (Protopam® Chloride) is diagnostic of poisoning by an organophosphate compound.

CARBAMATES

Carbamates are reversible cholinesterase inhibitors. Like organophophates, they may be direct or delayed in action. Inhibition of the enzyme is reversed largely by hydrolysis of the carbamylated enzyme and to a lesser extent by formation of fresh enzyme. Signs and symptoms of intoxication are similar to those of organophosphate poisoning. These include vague feeling of malaise, hyperhidrosis, light-headedness, nausea, blurring of vision, hypersalivation, and vomiting.

Diagnosis by measurement of cholinesterase activity is difficult. Without proper sample and handling, test results will err in the direction of normalcy.

CHLORINATED HYDROCARBONS

Chlorinated hydrocarbon insecticides are more persistent in the environment than most other synthetic organic pesticides. They are most efficiently absorbed by ingestion. The exact mechanism of toxic action of these chemicals is not known, but in general they act on the central nervous system to stimulate or depress. Signs and symptoms of toxicity therefore vary with the specific chemical but may include nausea, mental confusion or semiconciousness, jerking of limbs, dizziness, lethargy, weakness, and anorexia. Symptoms have been reported as soon as 30 minutes after massive exposure but generally develop more slowly; if maximum symptoms are not reached within a few hours after acute exposure, another diagnosis or complicating feature must be sought.

DIAGNOSIS AND TREATMENT

Diagnosis is confirmed by proof that the chemical or its metabolite is present in the body at excessive levels. The preferred material for analysis depends on the route of exposure, the suspected etiologic agent and the interval since exposure. Treatment must not be delayed awaiting laboratory confirmation, because such tests are difficult to perform and time-consuming. Results may not be available for days or weeks.

In the care of pesticide poisoning victims, three types of treatment are important:

1. **Supportive therapy.**
2. **Decontamination of patient.**
3. **Administration of specific antidotes where available.**

SUPPORTIVE THERAPY does not counteract the specific toxic action of the chemical but does sustain the several vital body functions necessary to the maintenance of life. Expressed bluntly, supportive treatment is supposed to keep the patient alive — until specific antidotes can be given and take effect or until the body has sufficient time to metabolize the total amount absorbed to a level which is no longer toxic. Supportive therapy is tailored to meet the needs of the patient and may include:

- artificial respiration
- maintenance of free airway (aspiration of excess secretion and vomitus)
- oxygen therapy for cyanosis (under positive pressure with pulmonary edema)
- postural drainage
- sedation for hyperexcitability or convulsions. (Sodium phenobarbital, preferred because of its rapid action, must be used with care when there is respiratory impairment).

CONTRAINDICATED:

- **MORPHINE, THEOPHYLLINE, OR THEOPHYLLINE-ETHYLENE-DIAMINE (AMINOPHYLLINE).**
- **TRANQUILIZERS ARE SELDOM INDICATED AND SOULD BE USED ONLY WITH GREAT CAUTION.**
- **STIMULANTS FOR VASCULAR COLLAPSE SHOULD BE USED ONLY AFTER CAREFUL CONSIDERATION. THEY ARE CONTRAINDICATED IN POISONING BY CHLORINATED HYDROCARBONS.**

DECONTAMINATION IS EXTREMELY IMPORTANT IN ALL TYPES OF POISONING. Such care properly administered terminates exposure and thereby limits dose; therefore poisoning victim should be decontaminated as soon as possible, even under less than ideal conditions. Depending on the nature of the exposure:

- evacuate to fresh air
- remove contaminated clothing
- wash skin and hair. (Thorough washing with soap and water followed by copious rinsing with water and possibly alcohol.) Rinse eyes with water or saline.
- induce vomiting or perform gastric lavage
- later, evacuate the gastrointestinal tract

CAUTION

- **DO NOT INDUCE VOMITING IN A STUPOROUS OR UNCONCIOUS PERSON.**
- **NOR WHEN PETROLEUM DISTILLATES ARE PART OF THE POISON FORMULATION.**
- **AVOID OILY LAXATIVES WHEN AN ORGANIC SOLVENT OR HALOGENATED COMPOUND IS INVOLVED.**

SPECIFIC ANTIDOTES are not available for all pesticide chemicals. *There are no antidotes for poisoning by the chlorinated hydrocarbons; however, antidotes of considerable effectiveness are available for use in poisoning by cholinesterase inhibitors, especially the organophosphates.* These antidotes are safe enough to administer cautiously on the basis of symptoms before the dianosis is firmly established. Favorable response to the antidote helps to confirm a diagnosis of poisoning by one of the cholinesterase-inhibiting compounds. Blood for cholinesterase testing should be drawn before antidotes are administered.

Atropine sulfate is a physiological antidote. It has no effect on the inhibited cholinesterase but blocks the action of acetylcholine on parasympathetic receptors alleviating bronchial spasm, reducing respiratory secretions, and alleviating miosis temporarily.

ATROPINE IS CONTRAINDICATED IN THE CYANOTIC PATIENT BECAUSE OF THE POSSIBILITY OF INDUCING VENTRICULAR FIBRILLATION. ATROPINE MAY, HOWEVER, BE GIVEN INTRAMUSCULARLY AT THE SAME TIME THAT ARTIFICIAL RESPIRATION IS INSTITUTED.

The proper dose of atropine sulfate for an adult is 2 to 4 mg intravenously as soon as cyanosis is overcome. (Doses for children whould be in proportion to weight; that is, about 0.05 mg/kg). The dose should be repeated at 5 to 10-minute intervals until signs of atropinization appear — dry, flushed skin, tachycardia as high as 140 per minute and drying of secretions. In all cases where atropine treatment is indicated, a mild degree of atropinization should be maintained for 24 hours and for 48 hours or more in severe cases. Because poisoning by organophosphate insecticides results in accumulation of an excess of acetylcholine at certain nerve endings, poisoned patients show an unusual tolerance for atropine. This tolerance is important diagnostically. The recommended dose of atropine sulfate is safe for the patient poisoned by an organophosphate pesticide but will produce clear signs of overdosage in a normal person.

2-PAM chloride is a specific antidote for poisoning by organophosphate compounds, acting to break the bond between acetylcholinesterase and the alkylphosphate metabolite of the organophosphate compound. This treatment is more effective if started early and following a single dose of poison than with illness as a result of repeated exposures as with workers. In organophosphate poisonings, 2-PAM chloride therapy should always be given in conjunction with atropinization.

The dose of 2-PAM chloride is 1 g for an adult and 0.25 g for infants. The drug is given *slowly* intravenously, preferably by infusion for 15 to 30 minutes. If infusion is not practical, the dose may be given *slowly* by intraveneous injection as a 5% solution in water over not less than 2 minutes. If the first dose produces some improvement, it may be repeated after an hour. In very serious cases a continuous infusion at the rate of 0.05 g per hour is recommended in adults and proportionally lower rates in children (Hayes, 1970).

Hayes, W. J., Jr. 1970. Epidemiology and general management of poisoning by pesticides. Pediatr. Clin. North Am. 17:629-644.

Side effects of 2-PAM chloride therapy are of minimal nature in normal subjects and practically nonexistent in people who have been poisoned. Complaints have included brief episodes of dizziness, blurred vision, diplopia, headache, nausea, and tachycardia. The material is rapidly excreted from the body, chiefly in the urine. There is a remote possibility of atropine intoxication in a patient who receives 2-PAM chloride after he has been given large doses of atropine because of the removal of accumulated excess acetylcholine by the freshly reactivated cholinesterase.

Patients who require treatment with antidotes should be watched closely and continuously for not less than 24 hours, because serious and sometimes fatal relapse can occur as a result of continued absorption of the poison when decontamination is incomplete or if dissipation of the effect of the antidotes occurs. Severely poisoned patients should have reasonably close observation for longer periods – up to 48 or 72 hours. Close medical supervision should be continued at least 24 hours after danger seems past. After discharge, the patient should avoid exposure to cholinesterase inhibitors until his blood cholinesterase activity has returned to normal. This will take several weeks and possibly months. It has been estimated that cholinesterase is regenerated at the rate of 1 percent per day.

In the case of poisoning by a carbamate pesticide chemical, only atropine alone should be administered in addition to general treatment by decontamination and supportive therapy. 2-PAM CHLORIDE IS NOT HELPFUL AND SHOULD NOT BE USED: IT MAY, IN FACT, BE HARMFUL. Many of the reported cases of carbamate poisoning have recovered without antidotal treatment (Tobin, 1970). Deaths have occurred with intentional ingestion (Reich and Welke, 1966).

PESTICIDE POISONING MAY MIMIC:

–Brain hemorrhage

–Heat stroke

–Heat exhaustion

–Hypoglycemia

–Gastroenteritis

–Pneumonia or other severe respiratory infection

–Asthma

Tobin, J. S. 1970. Carbofuran: a new carbamate insecticide. J. Occup. Med. 12:16-19.
Reich, G. A., and J. O. Welke. 1966. Death due to a pesticide. N. Engl. J. Med. 274:1432.

Determination of Pesticide Exposure When Poisoning Is Suspected

Biological Sample (In Glass Container)	Collection and Storage	Assays for Organochlorines	Assays for Organophosphates (Example, Parathion)	Assays for Carbamates (Example, Carbaryl)
Blood	10 ml, refrigerate or freeze (separate cells before freezing)	Parent compound* or known metabolite (Example, DDT)	Cholinesterase activity;** Parent compound	Parent compound, Cholinesterase activity**
Urine	100 ml, acidify and add 1 ml preservative or freeze	Metabolite if known (DDA for DDT)	p-nitrophenol, total alkyl phosphates (Parathion)	1-naphthol or other phenol metabolites as known
Gastric contents	Acidify and add preservative or freeze	Parent compound	Parent compound	Carbaryl, Parent compound
Body tissue	500 mg to 5 g (pea size), weigh and freeze	Parent compound or known metabolite (DDT, DDD, DDE)	Parathion	

* Any anticoagulant except heparin suitable.
** Heparinized blood; separate cells and plasma.

Note: Use chemically clean glass containers with foil- or teflon-lined screw caps. Where appropriate, sample may be wrapped in foil before being put in glass container.

Modified from Morrison, G. and W. F. Durham. 1971. Analytical diagnosis of pesticide poisoning. J. Am. Med. Assoc. 216(2):298-300. Reprinted with permission from author and publisher.

HOW DO ACCIDENTAL PESTICIDE POISONINGS OCCUR?

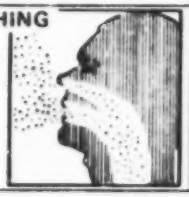
BY MOUTH

- DUSTS AND SPRAYS ENTERING MOUTH DURING AGRICULTURAL APPLICATIONS
- DRINKING PESTICIDES FROM UNLABELLED OR CONTAMINATED CONTAINER
- USING THE MOUTH TO START SIPHONAGE OF LIQUID CONCENTRATES
- EATING CONTAMINATED FOOD
- TRANSFER OF CHEMICAL TO MOUTH FROM CONTAMINATED CUFFS OR HANDS
- DRINKING FROM CONTAMINATED BEVERAGE CONTAINER

THROUGH THE SKIN

- ACCIDENTAL SPILLS ON CLOTHING OR SKIN
- DUSTS AND SPRAYS SETTLING ON SKIN DURING APPLICATION
- SPRAYING IN WIND
- SPLASH OR SPRAY IN EYES AND ON SKIN DURING POURING AND MIXING
- CONTACT WITH TREATED SURFACES AS IN TOO EARLY RE-ENTRY OF TREATED FIELDS, HAND HARVESTING, THINNING, CULTIVATING, IRRIGATING AND INSECT OR PEST SCOUTING
- CHILDREN PLAYING –
  IN DISCARDED CONTAINERS
  IN PESTICIDE MIXING OR SPILL AREAS
- MAINTENANCE – REPAIR WORK ON CONTAMINATED EQUIPMENT

BY BREATHING



- DUST, MISTS, OR FUMES
- SMOKING DURING APPLICATION
  OR
- CONTAMINATED SMOKING SUPPLIES

Wolfe, H. R. 1971. Hazards to and protection of individuals who mix or apply pesticides. Presented at the training course "Safety and Pesticide Usage." Atlanta, Ga., September 13-16, 1971. Sponsored by Division of Pesticide Community Studies, U.S. Environmental Protection Agency, Chamblee, Ga.

HOW MAY PESTICIDE POISONING BE PREVENTED?

- Read, understand, and follow recommendations on the label
- Protective clothing and equipment. . . .

  decrease the amount of pesticide chemical that has an opportunity to enter the body. Such are needed when using pesticides that show on the label.

"POISON"

Use This Protective Clothing

- *Lightweight rubber or plastic suit (full-length sleeves and legs, closed at neck and wrists) over usual work clothes.* Protective clothing may be hot. If use of waterproof suits is rejected, a *clean* heavy-duty cotton coverall is better than no protection at all.
- *Wide-brimmed hat or hood (lightweight rubber, plastic, or plastic-coated)*
- *Gloves and boots (rubber or plastic-coated)* Avoid canvas or leather type.

Use This Gear

- *Goggles*
- *Mask or respirator covering nose and mouth*
  Replace filters in cartridge-type respirators regularly.
- *Clean clothing and gear after each use*

- Store chemicals under lock and key and in original container
- Buy only the amount of pesticide needed for the job
- Regular cholinesterase testing and medical surveillance of all who are occupationally exposed to organophosphates.

CASES FROM LITERATURE

Case 1

A 22-year-old tractor driver disked a citrus orchard in which the trees were low and close set. The orchard was still posted with warning signs because parathion had been applied 8 days earlier. He removed his shirt because of the heat. As he worked, he brushed against the trees, and he had had similar exposures previously. In the early afternoon he became violently ill and called a nearby pest control operator who gave him some atropine tablets (which were lost) and had him taken to a hospital. Clinical manifestations on arrival included an ashen color with mild cyanosis, vomiting, abdominal cramps, a feeling of "numb all over" and pinpoint pupils which still reacted to light and accomodation. He was given atropine (0.3 mg I.V. and 0.09 mg I.M.) with an immediate sense of relief. His pupils dilated, but vomiting continued for 2-1/2 hours. He slept soundly until morning when his pupils were again noted to be contracted, and other symptoms returned. Atropine (0.6 mg subcutaneously) brought relief, and he recovered without further treatment.
(Quinby and Lemmon, 1958)

Case 2

An orchardist sprayed his apple orchard with parathion for a week and started thinning the sprayed trees 2 days before spraying was completed. Seven days after starting thinning, he became dizzy and had visual disturbances. When he reached home, he was nauseated and vomited, had "heaviness" of his legs and excessive sweating, and was noted to have pinpoint pupils. His physician treated him with atropine with fairly prompt relief. Three weeks later his plasma cholinesterase was normal, but the erythrocyte cholinesterase was still depressed. In retrospect, 4 hours before the patient realized that he was ill, both he and his daughter, who had been helping him, developed twitching of the eyelids, but the significance of this was not recognized.
(Quinby and Lemmon, 1958)

Case 3

A 2-1/2 year-old child was found playing with a package of spray powder (lindane and malathion). She had broken the package and scattered the powder widely but had little in or around her mouth. Gastric lavage was completed within 40 minutes at a local hospital where 0.6 mg atropine was injected. In the next 30 minutes she was driven to another hospital for admission to the intensive care unit. Immediately after admission, she became comatose and cyanotic with severe pulmonary edema and copious amounts of pharyngeal exudate. The child was intubated and given positive pressure artificial respiration. She developed extensor spasms, and the pupils dilated. The child was treated with atropine and pralidoxime for 2 days and replacement transfusion of 10 pints blood was done. The child remained decerebrate, conciousness was not regained, and she died 2 days after exposure. At autopsy, pulmonary edema and extensive cerebral softening were the principal findings.
(McQueen et al., 1968)

Case 4

A crew of 30 men, previously unexposed to pesticides, picked oranges for 8 hours in a grove which had been sprayed 16 to 19 days previously with parathion. Illness began in seven men shortly after lunch, in three others later the same day, and in one the next day with general symptoms of weakness, vomiting, and profuse sweating. One was almost unconscious, and two hardly able to see. All were hospitalized and treated with atropine.
(Quinby and Lemmon, 1958)

Quinby, G. E., and A. B. Lemmon. 1958. Parathion residues as a cause of poisoning in crop workers. J. Amer. Med. Assoc. 166:740-746.

McQueen, E. G., C. Brosnan, and D. G. Ferry. 1968. Poisoning from a rose spray containing lindane and malathion. N. Z. Med. J. 67:533-537.

Case 5

After an absence of 45 minutes, a 17-year-old boy was found unconscious on his bed with a soft drink bottle containing 4 ounces of dark brown malodorous liquid on the floor. He had vomited. He was taken to a hospital where he remained comatose with bilateral pinpoint pupils and irregular pulse. Emergency procedures temporarily restored a regular heart rhythm and sustained ventilation through a tracheostomy, but he developed recurrent heart failure and died 4-1/2 hours after ingesting the liquid. Laboratory tests established that the material in the bottle and that in the gastric contents was identical, but the material could not be identified. Blood cholinesterase tests were normal with no changes consistent with organophosphate exposure. It was suspected that the material was a carbamate. Inspection of the entire home environment revealed nothing resembling the suspect material. It was learned the victim had worked at a plant nursery. There, a large supply of pesticides was found in an unlocked building, among them material which proved to be identical to the causative material which proved to be a carbamate.
(Reich and Welke, 1966)

Case 6

A woman sprayed her flowers twice with malathion using a hand sprayer. On each occasion she thought she was poisoned when she developed headache, nausea, and dizziness. Her family had also sprayed the nearby orchard with what she thought was malathion, but investigation showed parathion had been applied. It also showed that she had worked in the orchard for some days after the application when residues were heavy on weeds. She wore the same dusty "pedal pushers" throughout, and her lower legs were bare. Each illness was preceded by further exposure to residues in the orchard.
(Quinby and Lemmon, 1958)

Case 7

At 8:00 AM, three 30-man crews began picking fruit sprayed 12 or more days previously with parathion. Testing had shown residues were not high on the fruit. Symptom onset ranged between 12:30 and 8:00 PM, with most men becoming ill between 2:30 and 4:00 PM. The ill men quit work, some lay down, and others went home. Those who were ill and remained at the farm were hospitalized when they began to vomit. Some 20 to 25 men were seen at the hospital, 2 coming by ambulance because of their condition. Among the patients, vomiting was fairly consistent and continuous along with subnormal temperatures, rapid pulse and excessive sweating, pallor, and weakness. Some also had vertigo and muscle twitching. Atropinization brought striking improvement in all within 20 to 25 minutes. Nine were detained overnight for observation, and some were given additional atropine in that time; two of these were hospitalized somewhat longer.

There were no illnesses among the crew who picked in the orchard area which had been spraved the earliest. All pickers had different lunches and water sources. Leaves tested for residues showed much higher levels than had been present on the fruit.
(Quinby and Lemmon, 1958)

INFORMATION ABOUT PESTICIDES IS AVAILABLE:

On the package label

The information on pesticide labels has been called the most expensive literature available, for the research and development that lead to the wording frequently costs millions of dollars. *If the label is read, understood, and all of the directions are followed, the likelihood of misusing the material or of having an accident with a pesticide is remote.* By law, the label on each package of pesticides must include the following:

Brand name
Intended product use
Active and inert ingredients – composition
Directions for use
Pests to be controlled; crops, animals, or sites to be treated
Dosage, time and method of application
Warnings to protect user, consumer of treated foods and beneficial plants and animals
KEEP OUT OF REACH OF CHILDREN
Antidotes and first-aid instructions
Net contents
Name and address of manufacturer
EPA registration number

Certain terms on the label are set by law. Signal words such as "Danger," "Poison," "Warning," and "Caution" reflect the degree of toxicity of the pesticide based on LD_{50} and LC_{50} values of the chemical.

From:

- **Your local poison Control Center** which maintains a current information file on all compounds, their constituents, and recommended treatment in case of poisoning.
- Your State department of health
- The County agricultural extension agent in your county
- The Regional Office of the U.S. Environmental Protection Agency

From selected reference texts:

Gleason, Gosselin & Hodge *Clinical Toxicology of Commercial Products.* 1969. The Williams and Wilkins Co., Baltimore, Md.

Goodman, L. S. *The Pharmacologic Basis of Therapeutics.* 1965. The Macmillan Co., New York, N.Y.

Hayes, W. J., Jr., 1963. *Clinical handbook on economic poisons.* Reprinted October 1971. U.S. Environmental Protection Agency. U.S. Government Printing Office, Washington, D.C. 20402.

Criteria for Cataloging Pesticides by Toxicity, and Label Requirements Established by Federal Insecticide, Fungicide and Rodenticide Act

	Acute Oral LD_{50} Value	Signal Word and Antidote Statements
Highly Toxic	0-50 mg/kg	"DANGER" "POISON" Skull and Crossbones Antidote Statement "Call Physician Immediately" "Keep Out of Reach of Children"
Moderately Toxic	50-500 mg/kg	"WARNING" No Antidote Statement "Keep Out of Reach of Children"
Low-Order Toxicity	500-5000 mg/kg	"CAUTION" No Antidote Statement "Keep Out of Reach of Children"
Comparatively Free from Danger	5000+ mg/kg	No Warning, Caution or Antidote Statement Unqualified Claims of Safety Are Not Acceptable "Keep Out of Reach of Children"

U.S. Dept. of Agriculture, Agricultural Research Service, Pesticides Regulation Division. March 9, 1962. Interpretation Number 18 of the Regulations for the Enforcement of Federal Insecticide, Fungicide, and Rodenticide Act. 7 C.F.R. 362, Int. 18, Rev. 2.

Classification and Therapy of Organophosphate Poisoning

1. Latent poisoning. No clinical manifestations. Diagnosis depends on the estimation of serum cholinesterase activity, which is inhibited by 10 to 50 percent.

   Treatment: Unnecessary, but observation for at least 6 hours is necessary, since clinical manifestations may progress.

   Prognosis: Good

2. Mild poisoning. The patient can walk but complains of fatigue, headache, dizziness, numbness of extremities, nausea and vomiting, excessive sweating and salivation, tightness in chest, abdominal cramps or diarrhea; serum cholinesterase activity is 20 to 50% of normal value.

   Treatment: Pralidoxime, 1 g intravenously, and atropine sulfate, 1 mg subcutaneously.

   Prognosis: Good.

3. Moderate poisoning. The patient cannot walk, and there is generalized weakness, difficulty talking, muscular fasciculations, miosis, and severe symptoms described above; serum cholinesterase activity is 10 to 20% of normal value.

   Treatment: Pralidoxime, 1 g intravenously; atropine sulfate, 1 to 2 mg intravenously every 20 to 30 minutes until sweating and salivation disappear, and there is slight flush and/or mydriasis.

   Prognosis: Recovery with treatment; without treatment, recovery may or may not take place.

ERRATA

Treatment (lines 4 and 5) should read:

"...atropine sulfate, 5 mg intravenously..."

4. Severe poisoning. Unconsciousness, marked miosis, and loss of pupillary reflex to light, muscular fasciculations, flaccid paralysis, secretions from the mouth and nose, moist rales in the lungs, respiratory difficulty and cyanosis; serum cholinesterase activity is lower than 10% of normal value.

   Treatment: Pralidoxime, 1 g intravenously; if there is no improvement, additional intravenous injection of 1 g; if the total of 2 g pralidoxime is not followed by improvement, intravenous infusion of pralidoxime at a rate of 0.5 g/hour; atropine sulfate, 5 g intravenously every 20 to 30 minutes until sweating and salivation disappear, and there is a slight flush and/or mydriasis.

   Prognosis: Fatal if not treated.

Other therapeutic measures: (1) Maintain open airway by oropharyngeal suction, endotracheal tube and bronchial suction, and maintain respiration by mechanical means, if necessary adding oxygen if available; (2) remove organophosphate from the skin and conjunctivas, or from the stomach by gastric lavage; (3) other supportive measures, including intravenous fluids, and antibiotics to handle pulmonary infection; diphenylhydantoin and other anticonvulsant drugs may be administered if convulsions are not relieved by atropine and pralidoxime.

This table is compiled mainly from experience with parathion and methyl parathion poisoning. There are some variations in poisoning due to other organophosphates. The doses of pralidoxime and atropine are for adults. Doses in children are in proportion to body weight or surface area.

From Namba, T., C. T. Nolte, J. Jackrel, and D. Grob. 1971. Poisoning due to organophosphate insecticides: acute and chronic manifestations. Am. J. Med. 50:475-492. Reprinted with permission from author and publisher.

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